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OCCURRENCE OF INGESTED LEAD SHOT IN ALBERTA DUCKS, 1977

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OCCURRENCE OF INGESTED LEAD SHOT
IN ALBERTA DUCKS, 1977

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ABSTRACT

Lead poisoning occurs when waterfowl swallow spent shotshell pellets while feeding or selecting grit. Ingested pellets which are not passed or voided are retained in the gizzard, where the grinding action converts the lead into a more soluble and toxic form. Relative toxicity depends upon a number of factors.

Recognized for many years as a source of waterfowl mortality, the use of lead shot has recently been prohibited in selected high-harvest areas of the United States.

While there has never been a confirmed major outbreak of lead poisoning in Alberta, the number of waterfowl harvested in recent years indicate that significant amounts of lead are expended annually in the province. Early in 1977, a study was designed to evaluate the degree to which lead poisoning may be a problem in Alberta. Methodology involved collecting duck gizzards in each of the seven Fish and Wildlife Division regions in Alberta during spring and fall, at locations known to support the heaviest hunting pressure. A small sample was also taken during August.

The spring collection consisted of 242 ducks taken from 28 locations throughout the province; during the summer, 74 ducks from eight locations were collected; the fall collection was comprised of 403 ducks from 31 locations in six of the regions.

Of the 719 gizzards collected and analysed, only three were found to contain ingested lead - each from a different season and region of collection. Thus, the incidence of ingested lead shot encountered in this study was very low, especially in view of the attempt to concentrate collecting in areas of high hunting pressure. Based on the results of this study, the extent of any lead shot problem in Alberta, and the resultant mortality of waterfowl due to lead poisoning, is considered to be insignificant. No remedial management methods or techniques are recommended; conversion to non-toxic shot, even on a limited or "hot-spot" basis, is not warranted. Relatively small sample sizes are acknowledged.

INTRODUCTION

Lead poisoning can occur when waterfowl swallow spent lead shotgun pellets while feeding or selecting grit in fields, marshy areas or on lake bottoms. The ingested pellets which do not pass through the digestive system are retained in the gizzard, where the strong grinding action erodes the lead and converts it into a more soluble form. Once into the blood stream, lead interferes with the digestive process, impairs the function of the heart and liver, and may affect the nervous system (Hartung, 1971). Field symptoms include general weakness of the voluntary muscles which may result in gradual paralysis, progressive starvation and greenish diarrhea.

The toxicity of lead to waterfowl depends upon a number of factors including, but not necessarily restricted to: size and general health of the bird; number, size and duration of the pellets retained; type and amount of grit; and previous and current diet. To illustrate the variable effects of dosing mallards with lead shot, Barrett and Karstad (1971) found that 60% (18 of 30) survived a dose of six No. 6 pellets, while Jordan and Bellrose (1950) found that a single No. 6 pellet killed 70% of their sample (7 of 10).

The Illinois Natural History Survey, in collaboration with Winchester-Western (Bellrose, 1959) has published a comprehensive study analyzing more then 36,000 duck gizzards collected across the United States. One of Bellrose's more widely-quoted conclusions is that annual loss of all waterfowl species to lead poisoning is estimated to be 2-3 percent of the fall population.

Application of Bellrose's 2%-3% lead poisoning mortality rate was included in a comprehensive final environmental impact statement, prepared by the U.S. Fish and Wildlife Service (1976), to indicate that from 1.6 to 2.4 million ducks may die from lead poisoning each year in North America. Other conclusions in the impact statement were that waterfowl hunters deposit lead shot pellets at the rate of 3,000 tons per year in the United States, that lead levels in duck tissues were lowest in the Central Flyway and highest along the Atlantic coast, and that current or annual deposits of lead are the sources of the lead poisoning problem in most locations.

As a result of these findings, the U.S. Secretary of Interior announced that a non-toxic substitute for lead shot would be phased in. Thus, the use of lead shot was prohibited in selected areas of the Atlantic Flyway in 1976, in selected areas of the Mississippi Flyway in 1977, and was banned in portions of the Central and Pacific flyways in the fall of 1978. In each Flyway, designated "steel shot zones" are established in areas of high hunter activity and harvest, where lead deposits have been most concentrated and where lead poisoning outbreaks would be most likely to occur.

Considerations for the modification of standard lead shot were proposed as early as 1936 (Green and Dowdell, 1936). Efforts to develop a non-toxic substitute, and relative toxicities of various alloys, were reported in a later paper (Jordan and Bellrose, 1950). In recent years, a number of studies on the toxicity of lead and various substitues (Irby _et_ _al_., 1967; Grandy _et_ _al_., 1968; Longcore _et_ _al_., 1974), and on their effectiveness and shooting qualities (Andrews and Longcore, 1969; Perret, 1973; Cochrane, 1976; Nicklaus, 1976; Mikula et al., 1977) have been published. Since 1971, numerous articles have also appeared in many sporting magazines and hunting periodicals as a result of extensive testing of lead shot substitutes by outdoor writers, shooting editors and ballistics experts. Results from the earlier tests were widely publicized among North American hunters and engendered a great deal of resistance to change within that fraternity. Some of the disadvantages of steel shot were reported to be barrel damage, reduced effective range, greater crippling loss and increased cost. While ongoing improvements in steel shot shells have significantly improved recent test results, much resistance to conversion still remains.

In Alberta, there has never been a confirmed major outbreak of lead poisoning, although waterfowl harvest estimates indicate the province has become a prime North American harvest area in recent years. (Cooch et al., 1978). In fact, there are a few larger wetlands in the proximity of major Alberta population centers where fall hunting pressure (and resulting lead shot deposition) might be described as comparatively heavy.

Therefore, early in 1977, a study was designed to evaluate the degree to which lead poisoning may be a problem in Alberta (Figure 1). The objective was to establish occurrence rates of ingested lead shot in ducks in Alberta. Gizzards were selected as the unit of study because of the ease of processing and analyzing, compared to other organs or tissue (eg. liver or wing-bones). They would also provide a basis for comparison with similar studies completed for other areas throughout the continent.

Figure 1. OUTLINE FOR ALBERTA LEAD SHOT STUDY

OBJECTIVE

To establish the occurrence of ingested lead shot in waterfowl in Alberta:
a) during the pre-nesting period (before mid-May)
b) just before (re)gaining flight (August)
c) preceding southward migration (October)

STUDY AREAS

a) In each of seven Alberta regions, at least one area known to support a moderate-to-high amount of over-water shooting during hunting seasons.
b) Five additional locations throughout the province known to be high waterfowl harvest areas.
c) Three areas where pre-season banding will occur in 1977.

PROCEDURES

Collection Method - shotgun or rimfire or trapping

Minimum Numbers - in spring, 5 mallards plus 5 others (species mixed), from each location
- in summer, 10 mallards plus 10 others (young-of-year), from banding areas only
- in fall, 5 mallards plus 5 others, from each spring location

Storage - entire gizzard removed and frozen, labelled by species, age, sex, location and date.

Analysis - in late 1977, gizzards to be thawed, tagged and X-rayed. Those testing 'positive' to be dissected and water-sorted under illuminated magnifier.

EXPECTED RESULTS

a) Spring rates may not necessarily be low in all collection areas; expected to vary by wintering areas and northward route.
b) Summer rates, from only young-of-year birds, expected to be extremely low, with possible "hot-spot" exceptions.
c) Autumn rates will probably be biased upward, caused by deliberately collecting or sampling in locales where shot deposition is considered to be abnormally high. Overall rates should be higher than the provincial average and reflect the upper limits of lead contamination in Alberta.

STUDY AREA

Each of the seven Fish and Wildlife Division regions in Alberta contain one or more lakes or marshes which annually support a relatively high volume of over-water shooting. Therefore, each Regional Biologist was asked to select at least one such area in his region for sampling during the spring and fall. Concurrently, a number of additional high-harvest areas were selected for sampling after consultation with the appropriate Regional Biologist and other personnel of the Fish and Wildlife Division, Canadian Wildlife Service and Ducks Unlimited (Canada).

METHODOLOGY

The rationale behind sampling areas with higher-than-average hunting pressure was two-fold: 1) if the overall occurrence of lead shot ingestion was to be biased by area selection, it would be biased upward to reflect the upper limits of shot deposition and lead contamination; and 2) if problem or "hot spot" areas did exist, they would be detected and would form a basis for further investigation.

The spring sample was intended to provide information on the prevalence of lead in ducks returning from wintering areas. Attempts were made to collect birds as soon after arrival as possible, to reduce the possibility that any ingested pellets found would have been acquired in Alberta. General wintering areas for ducks breeding throughout the province are reasonably well known, but a great deal of speculation would be required in relating an area of contamination to a bird carrying ingested shot in Alberta in May.

It was felt, however, that a high rate of occurrence among ducks in one or more general portions of the province might provide a reasonable basis for speculation.

Waterfowl collected during the summer (August) consisted of both adults and young-of-the-year taken primarily on natal or molting areas. Most ducks surviving the ingestion of lead shot are lead-free within five weeks, having either passed the pellets or survived the effects (Barrett and Karstad, 1971; Roscoe et al., 1976). It was assumed all flightless young and most molting adults, collected during August, which carried ingested lead pellets, would have acquired the shot on or very near the water area where collected. It was further assumed that any pellets ingested would have been deposited during the previous fall hunting season, providing some measure of sustained availability after eight months and perhaps a further indication of the fall hunting pressure for that particular area.

Scientific kill permits were issued by the Canadian Wildlife Service, under authority of the Migratory Birds Convention Act and Regulations, to personnel involved with the spring and summer collecting of ducks. Most permits contained a waiver of Regulation 15.(3), enabling the permittee to collect spring arrivals by use of .22 rimfire rifle until May 21, 1977.

Ducks collected during the spring portion of the study were taken primarily with the use of shotguns, and secondarily by .22 rifle. Most of the summer segment was taken by shotgun, as was the fall sample which was collected during the regular open season.

Each person collecting birds during the fall was requested to postpone collection activity until at least three week-ends of the regular hunting season had elapsed in the particular Bird Game Zone being sampled. It was felt this would allow some shot deposition by the hunting public while also allowing time to obtain a representative sample.

No concerted efforts were made to collect gizzards from hunter-shot ducks via field contact or check stations, nor was the study officially publicized. In those cases where a significant number of gizzards could be obtained without causing either the hunter or the collector undue inconvenience, they were gladly acquired providing the precise kill location could be recorded.

Gizzards were tagged with information on species, sex, date and location, and frozen in plastic bags. In early December, they were sorted by region and date and, after being individually coded and catalogued, were returned to the freezer.

Through prior arrangements made by the R.C.M.P. Migratory Birds Coordinator, 691 duck gizzards were taken to the Crime Detection Laboratory, Edmonton, in mid-December for preliminary screening. The gizzards were fluoroscoped in lots of 16 on a Picker Portable X-ray unit with a 10 inch diameter viewing screen. Those 56 gizzards which tested positive for the presence of lead pellets or similar dense substances were separated and set aside; the remaining 'clean' gizzards were discarded.

The 'positive gizzards' were then individually dissected in the Red Deer laboratory, and the contents inspected under an illuminated magnifier. The outer surface and inner membrane lining of each gizzard were scrutinized for evidence of perforation or hemorrhaging which would indicate the pellet(s) had been shot-in rather than ingested.

Three weeks later, 28 gizzards from two late-season hunts at Wabamun Lake were received. These were X-rayed and fluoroscoped at Red Deer General Hospital and three were found to contain shot. The procedure outlined above was also followed for this sample. A complete list of the numbers of each species collected during the three 1977 seasons is given in Table 1.

Table 1. Numbers of ducks collected and gizzards analyzed in Alberta, 1977 - by species.

	SEASON OF COLLECTION			
Species	Spring	Summer	Fall	Yearly Total
Mallard	119	10	214	343
Gadwall	6	8	13	27
American widgeon	8	4	23	35
Green-winged teal	9	6	35	50
Blue-winged teal	29	19	19	67
Shoveler	13	13	18	44
Pintail	31	5	41	77
Unknown			13	13
Sub-Total	215	65	376	656
Redhead	7	3	3	13
Canvasback	1	1	1	3
Lesser scaup	16	4	11	31
Goldeneye	1		1	2
Bufflehead		1	7	8
Scoter			1	1
Ruddy	1		3	4
R.b. merganser	1			1
Sub-Total	27	9	27	63
TOTAL DUCKS	242	74	403	719

RESULTS AND DISCUSSION

Although there has never been a confirmed outbreak of lead poisoning in Alberta, a few isolated cases have been reported and lead has been suspected as the major cause of death in a few others. At least part of the reason why lead poisoning has not been a serious problem in the province is due to the types of hunting conducted and the nature of the wetlands themselves. A significant portion of Alberta's annual duck harvest occurs in grain fields or on the innumerable small sloughs and potholes found throughout the province. In many instances, spent shot does not fall into water or, where it does, the water bottom is soft and the pellets sink out of reach of feeding ducks. Due to the relative abundance of other water areas available to the birds, any given wetland seldom sustains much hunting pressure for any length of time. In addition, each year from 45 to 50 of the better staging lakes and migration stops have a ½ mile shoreline restriction on bird hunting until November 1st. There are few large wetlands in Alberta where over-water hunting pressure might be described as "heavy", or where the annual deposition of lead shot could be considered substantial.

SPRING COLLECTION

From April 6 - May 30, 1977, 242 ducks were collected from 28 locations (Table 2). Of these, mallards were the most numerous (119 or 49.2%) of the 12 species, followed by pintail (31 or 12.8%) and blue-winged teal (29 or 12.0%). Only one bird from the spring sample contained ingested lead shot. A single No. 6 pellet was found in the gizzard of an adult male mallard collected at Stirling Lake, south of Lethbridge, on April 13. Six other mallards and seven other ducks also collected at Stirling Lake during April tested negative for the

Table 2. Numbers of ducks collected and gizzards analyzed in Alberta, 1977-by Fish and Wildlife Divison region.

	SPRING		SUMMER		FALL		TOTAL	
Region of Collection	Number Locations	Number Gizzards	Number Locations	Number Gizzards	Number Locations	Number Gizzards	Number Locations	Number Gizzards
1. Lethbridge	4	39					4	39
2. Calgary	4	30			3	27	5	57
3. Red Deer	5	28			5	58	10	106
4. Edson	1	12			2	26	2	38
5. St. Paul	3	28	5	18	12	128	18	174
6. Peace River	6	52			4	65	7	117
7. Edmonton	5	53	3	56	5	99	8	208
Prov. Total	28	242	8	74	31	403	54	719

presence of shot. The spring occurrence rate of ingested lead was 0.8% for mallards and 0.4% for total ducks.

SUMMER COLLECTION

This collection consisted of 74 ducks from 8 locations in the Edmonton-St. Paul area. Blue-winged teal were the most prevalent (19 or 25.7%), followed by shoveler (13 or 17.6%) and mallard (10 or 13.5%). One gizzard from an adult female blue-winged teal, collected August 12 on Ben's Lake, contained ingested shot. Again, one No. 6 lead shot was found during dissection. Twenty-four other ducks collected at Ben's Lake on the same date, of which 13 were blue-winged teal, all tested negative. Of the summer sample, 1.4% of the total ducks and 5.3% of the blue-winged teal contained ingested lead.

FALL COLLECTION

A total of 403 ducks was collected from 31 locations during September 1 to December 17. The most numerous species were mallard (214 or 53.1%), pintail (41 or 10.2%) and green-winged teal (35 or 8.7%). However, some of these were collected within three weeks of the opening day of the season, or were taken in fields or over very small wetlands, and should not be considered as representative of the potential problem areas (Table 3). They do, however, represent the "true situation" prevalent throughout much of the province and will be included in the overall calculations, unless indicated otherwise.

Of the 403 gizzards collected and analyzed for the fall period, only one contained ingested lead. A juvenile male mallard taken on October 17 at Lac Magloire, south of Peace River, contained a single No. 4 pellet. This represented an occurrence rate of 0.5% for all mallards and a rate of 0.2% for total ducks. When only birds taken from large wetlands and later in the season are considered, the occurrence rate is 0.6% for mallards and 0.3% for all ducks. Six other mallards, two lesser scaup and one gadwall also taken at Magloire on the same trip, proved negative for the presence of ingested shot.

Table 3. Numbers of ducks collected and gizzards analyzed from various aspects of fall collections, by species.

	Time and General Area of Collection			
	First 2 weeks of season	Fields or small wetlands	Larger Lakes and late season	Fall Total
Mallard	33	17	164	214
Gadwall	3	2	8	13
American widgeon	4		19	23
Green-winged teal	1		34	35
Blue-winged teal	13		6	19
Shoveler	4	1	13	18
Pintail	15	1	25	41
Unknown		9	4	13
Sub-Total	73	30	273	376
Redhead			3	3
Canvasback			1	1
Lesser scaup	1		10	11
Goldeneye			1	1
Bufflehead	1		6	7
Scoter			1	1
Ruddy			3	3
Sub-Total	2		25	27
TOTAL DUCKS	75	30	298	403

TOTAL COLLECTION

All three ingested lead pellets recovered appeared to be in good or new condition, with no erosion or distortion evident. All three birds were in apparent good health at time of collection and did not seem to be suffering the adverse effects of lead toxicosis. It is, therefore, assumed that ingestion had occurred within a relatively short period before the birds were shot. It could be further assumed that the blue-winged teal from Ben's Lake and the mallard from Lac Magloire picked up their respective pellets locally, but the acquisition by the Stirling Lake mallard is more open to speculation. It is possible that particular pellet had been ingested on, or enroute from, the wintering area before entering Alberta, but it seems more likely it was acquired from or near Stirling Lake. Early arriving mallards and pintails had been in the Lethbridge area for at least two weeks prior to the date of collection of this particular bird, allowing ample opportunity for the pellet to have been picked up locally.

All three lakes from which affected ducks were collected - Stirling, Ben's and Magloire - serve a variety of waterfowl needs during the course of the year. All are fairly large in size, marshy in nature with abundant emergent vegetation, and provide a fair amount of good hunting during the fall. Each serves as a spring dispersal area for local breeders and resting area for northbound migrants, as a summer brooding area, as a molting marsh, and as a fall staging area. Each was among those wetlands pre-supposed to be a possible problem area at the commencement of the study, due primarily to their attractiveness to waterfowl and the resulting hunting pressure.

In summary, the results from the study can be presented as follows:

1. Of 242 ducks collected during April-May at 28 locations throughout Alberta, 119 (49.2%) were mallards. One duck, a mallard taken at Stirling Lake on April 13, carried ingested lead. Spring occurrence rates were determined to be 0.8% for mallards and 0.4% for all ducks sampled.

2. In August, 74 ducks were collected at 8 locations in central and east-central Alberta, with blue-winged teal the most numerous species in the sample (19 or 25.7%). A blue-winged teal taken August 12 at Ben's Lake proved to be the only bird in the summer collection with ingested shot in the gizzard. Occurrence rates determined from this sample were 5.3% for blue-winged teal and 1.4% for total ducks.

3. During the regular fall hunting season, 403 gizzards were collected from 14 species of ducks taken at 31 locations throughout the province. The most numerous species was the mallard, comprising 53% of the total. One mallard shot on October 17 at Lac Magloire had lead shot in the gizzard at the time of collection. When the numbers of birds collected from small wetlands or fields or early in the season are excluded, then 0.6% of the mallards and 0.3% of the ducks sampled carried ingested lead. When all dates and areas of collection are considered, then gizzards from 0.5% of the mallards and 0.2% of the total ducks contained spent shot.

4. The overall occurrence rate, for all areas and seasons of collection combined, was 0.4% (3 of 719). The sample sizes from the summer and fall seasons of collection are recognized to be rather small, considering the geographic area involved and the magnitude of the annual duck harvest.

5. Of 54 sites or locations where ducks were sampled, three (5.6%) furnished birds with ingested shot. No site or location provided more than one affected duck. Twelve locations were sampled both spring and fall.

6. The three duck gizzards found to contain ingested lead shot harbored a single pellet each.

7. It is believed the blue-winged teal taken in August and the mallard shot in October ingested the shot within Alberta, probably in the immediate vicinity of collection. The likelihood is high that the April mallard did also.

8. The presence of lead shot in the August gizzard strongly suggests the persistence of spent pellets from the 1976 hunting season.

9. The results of this study show very low seasonal and annual occurrence rates of ingested lead in Alberta ducks. Several lakes and marshes known to be areas of relatively high hunting pressure were sampled and provided negative results. No "hot spot" area was detected.

CONCLUSIONS AND RECOMMENDATIONS

1. The nature and extent of hunted areas (and types of hunting) play a significant but unquantified role in the low occurrence rates established in this study.

2. Based on gizzard analysis during this investigation, lead poisoning of waterfowl in Alberta is insignificant from a provincial, regional and local perspective.

3. Because of the low incidence of occurrence encountered in this study, no remedial management recommendations are required. Practices or methods such as seasonal flooding or de-watering of wetlands, area closures to hunting during alternate years, or partial conversion to non-toxic (steel) shot, are unwarranted.

4. A similar study should be conducted in the early or mid-1980's, and should include standard techniques for sampling and evaluating wetland soils and marsh bottoms for the presence of spent lead. A larger sample size could be obtained by actively soliciting and collecting gizzards or other organs or tissues from waterfowl hunters.

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